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**The Economics of Natural Gas in  
Mexico - Revisited**

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## The Economics of Natural Gas in Mexico - Revisited

*Michelle Michot Foss,\* Francisco Garcia Hernandez,\*\*  
and William A. Johnson\*\*\**

*How long will Mexico continue to be a net importer of natural gas? We explore this question and raise the logical corollary—will import volumes increase? During 1992, gas imports by Mexico peaked at 300 to 350 MMcf/d, primarily to serve incremental demand in Mexico's northern region. We begin our investigation by suggesting that natural gas demand in Mexico is a function of GDP and the real price of gas, the latter being tied to U.S. prices. Low U.S. gas prices have driven Mexico's import strategies. If downward pressure on U.S. gas prices continues, the import market in Mexico could be preserved through the end of this century. Other factors contribute to the prospects of a long-run import strategy, in particular, capital investment constraints at Pemex; the need to substitute cleaner burning natural gas for the residual fuel oil used widely in Mexico; and a North American free trade zone which may encourage greater gas imports by Mexico. We conclude that it is reasonable for Mexico to remain a net importer of gas for at least the next 10 years.*

### INTRODUCTION

Imports of natural gas by Mexico grew from less than 20 Bcf in 1990 to approximately 95 Bcf during 1992. While these imports are predominantly from U.S. gas companies, Canadian companies are also entering the Mexican market. The pattern of gas flows established in the past three years has triggered the inevitable question: Will the United States and Canada be long-run suppliers of natural gas in Mexico? To address this question, we organize our discussion

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in terms of demand for natural gas in Mexico, supply of natural gas from domestic production and for export to Mexico, and the key political issues that have implications for the Mexican natural gas market, principally free trade. We argue that the critical variables impacting the supply-demand balance in Mexico's gas market are as follows: (1) economic activity in Mexico, (2) patterns of gas consumption and the geographic location of reserves in Mexico, (3) investment in and the organization of Mexico's petroleum sector, (4) U.S. gas price trends and availability of U.S. and Canadian gas, and (5) cross-border transportation capacity. In the political arena, consummation of a North American Free Trade Agreement (NAFTA) may preserve natural gas imports by Mexico. We conclude that Mexico is likely to remain a net importer of gas for at least 10 years. However, we also raise some caveats to that outlook—principally the lack of markets for high-sulfur residual fuel oil displaced by increased gas consumption in Mexico. The latter could cloud the picture for long-term imports of natural gas by Mexico. Devising solutions for the disposal of displaced residual oil will have the greatest effect on gas import volumes.

### Review of Mexico's Gas Market

Mexico was a net exporter of gas until 1985. By 1992, with daily volumes of 300 to 350 MMcf, Mexico was importing slightly more than it exported in 1981. In an earlier paper, Foss and Johnson (1991) argued that the primary factor influencing this growth in imports was the low price of U.S. gas, primarily because of surplus deliverability in the United States and tax credits for "unconventional" gas produced from coal-bed methane. Because of these factors, Foss and Johnson reasoned that the United States might enjoy a window of opportunity to export to Mexico, at least for the life of the tax credit, year-end 2002. We argue more broadly here that, as long as U.S. gas is favorably priced, the economic advantages of importing natural gas will continue. We focus on U.S. gas prices because the ongoing natural gas pricing policy at *Petróleos Mexicanos* (Pemex, Mexico's state oil company) is to take an average of prices reported by five U.S. producers. To this average price, Pemex adds transportation costs and taxes. The Mexican gas price, therefore, changes with variation in the U.S. average.<sup>1</sup>

Foss and Johnson also reported that the politically expedient view within Pemex was that gas imports were temporary. To a large extent, this still holds. We suggested that a benefit of importing natural gas is the freeing up of investment capital for crude oil development. Mexico's willingness to pay hard

1. Pemex follows a similar strategy in pricing residual fuel oil in Mexico, some of which is also imported.

currency for gas imports is, however, very sensitive to overall economic and fiscal conditions. An important component of Pemex's current operating plan is, as always, to increase crude oil production in order to maximize export revenues. This strategy is now couched more in an emerging philosophy that operations should be rationalized, with imports of natural gas being one result of this philosophy.

Does a long-term trading relationship make economic sense? U.S. and Canadian gas prices reflect maturity of production and lower costs associated with prior investment in infrastructure necessary to move gas to markets. Consequently, Mexico's northern neighbors are currently benefiting from the comparative advantage held by their gas resources. Mexico has substantial gas reserves, but continues to face severe constraints on the financial and physical capital needed to exploit these reserves. Thus, the tendency to import is as much a function of Mexico's ability to fund natural gas exploration, development, and transmission and other infrastructure as it is a function of price. In terms of absolute advantage, however, the extent of unexploited gas resources in Mexico, efficiencies gained from reforms at Pemex, and free-trade induced opportunities—such as the employment of U.S. and Canadian companies in drilling programs, and the ability of Pemex to purchase at least some goods and services from U.S. and Canadian oil service companies—may serve to preserve Mexico's long-term absolute advantage. It is probably safe to conclude that a long-term trading relationship will remain, but that it will eventually encompass net exports of gas from Mexico. Any long-term market for imported gas in Mexico will be geographically differentiated; U.S. and Canadian companies may continue to supply users in northwestern Mexico, while Mexican gas flows through the northeastern tier of the country to supply U.S. consumers.

## DEMAND FOR NATURAL GAS IN MEXICO

### Aggregate Demand

Mexico consumed about 4 Bcf per day of gas in 1992. Growth in the consumption of natural gas in Mexico is primarily a function of economic output (Garcia, 1992). The link between economic activity and apparent natural gas consumption in Mexico is more evident after 1986, as Figure 1 demonstrates. In recent years, growth in natural gas consumption has been such that apparent consumption exceeds domestic production (Figure 2), so that Pemex has been faced with stepping up domestic production or importing more gas. Preliminary modeling suggests that economic variables (national income, or GDP) are very important to the consumption of natural gas, but that real price of natural gas is also critical, though not in the same time period.

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Figure 1. Mexico Economic Activity and Natural Gas Consumption

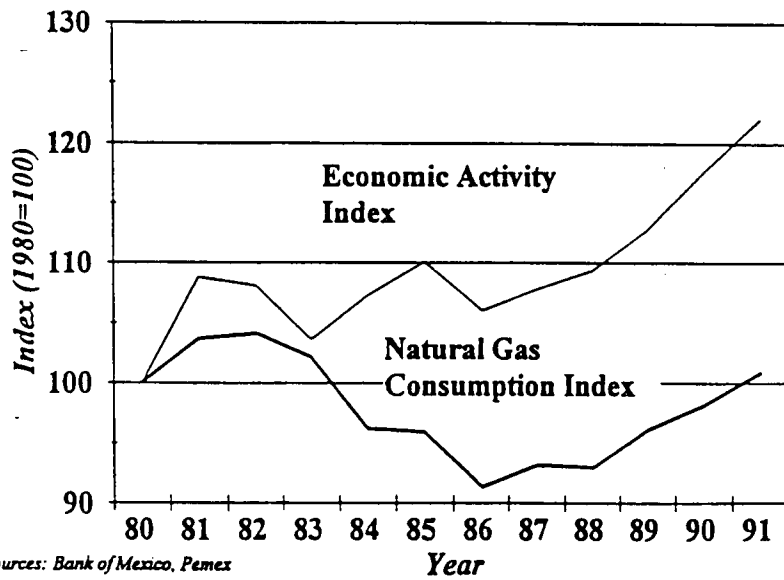


Figure 2. Mexico Natural Gas Production and Consumption

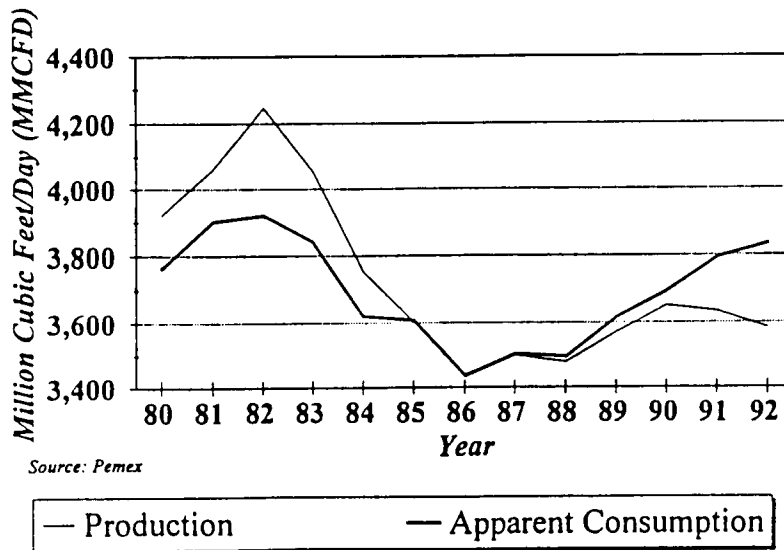


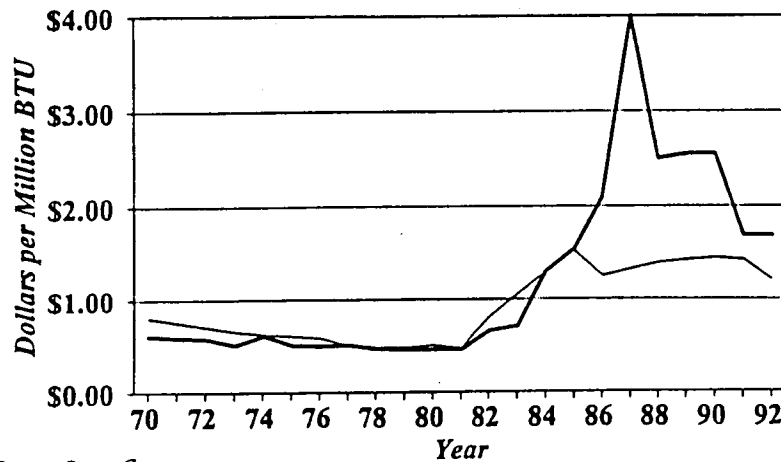
Table 1. Distribution of Natural Gas Use in Mexico

Sector	Percent Total Consumption	Planned New Capacity to the Year 2000: 6,500 MW <sup>a</sup>
Petrochemicals	35	Natural Gas <sup>b</sup> - 50%
Other Industry	25	Coal - 30%
Energy <sup>c</sup>	24	Fuel Oil - 10%
Electric Power Production	11	Nuclear <sup>d</sup> - 8%
Residential	3	Geothermal - 2%
Unspecified	2	

Notes: <sup>a</sup>Based on the CFE's latest plans; <sup>b</sup>Most gas-fired units are located in northern Mexico, particularly Tijuana and Ciudad Juarez; <sup>c</sup>Natural gas used in field operations and production; <sup>d</sup>Second unit at Laguna Verde.

Sources: All consumption data taken from the 1992 edition of Natural Gas Trends, published by Cambridge Energy Research Associates and Arthur Andersen Co. Data on CFE plans provided by sources at Pemex.

Figure 3. Price of Gas vs. Heavy Fuel Oil



Sources: Pemex, Gas Industrial de Monterrey

— Gas — Heavy Fuel Oil

What are the sources of growth in natural gas demand? Table 1 indicates natural gas consumption as of 1989. Based on the data in Table 1, one might anticipate sustained overall growth in the consumption of natural gas in Mexico. The NAFTA, coupled with changes in Mexico's petrochemicals industry that have already taken place, could continue the process of privatization and increase the output of petrochemicals. This bodes well for gas use by this sector, but we note that this may be a longer term adjustment. In the shorter run, the shut down or conversion of inefficient plants may constrain growth in gas consumption. With regard to gas used in the energy sector, Pemex has (according to its own data) made great strides over the years in reducing the amount of gas that is flared from more than 20% to around 2-3% of current production. Pemex should continue to make efficiency gains in field operations, which would free up gas for other uses. The 3% level of gas use in Mexico's residential sector contrasts with 25% in the U.S. residential use and is a potentially ~~potent~~ growth sector in Mexico. However, little infrastructure for residential gas distribution exists in Mexico, so that increased consumption in this sector would come only at a substantial cost.

The 11% of Mexico's gas consumed in electric power generation compares to 15% of gas consumption for electric power in the United States. As in the United States, the electric power sector in Mexico is considered to be a source of strong demand growth for gas. The *Comision Federal de Electricidad* (CFE, the state electric power utility) is considering a significant increase in natural gas use for new and expanded generating capacity. The CFE's plans hinge on the ability of the CFE to secure financing (Durbin, 1992).<sup>2</sup> Partial or complete conversion of electric power utility boilers from residual fuel oil to gas, and switching to gas for other, non-petrochemical industrial applications, offers the potential for new growth in demand for gas in Mexico. Displacement of residual fuel oil is also supported by environmental interests.

One question is whether growth in natural gas consumption is also a function of the competing price of high-sulfur residual fuel oil. In recent years, high-sulfur resid has been priced well below natural gas. Resid is used extensively in both Mexico's electric power and non-petrochemical industrial sectors. Figure 3 shows the price disparity between the more expensive gas and resid beginning in 1970. The price advantage of resid fuel oil over gas diminished since 1986 as a result of declining U.S. wellhead prices for gas and changes in Pemex's pricing policies. Further research is necessary to better understand the dynamics of the gas-oil trade off.

2. Comments also from planning/economics staff at the CFE and Pemex. The original forecast of 8,000MW of new capacity reported by Durbin has been reduced to the current 6,500MW forecast in response to budget cuts.



Our preliminary modeling suggests that price competition between natural gas and residual fuel oil is not a good predictor of aggregate demand for natural gas in Mexico.<sup>3</sup> However, the use of high-sulfur residual oil poses a *critical* constraint to expanding natural gas applications with consequences for natural gas imports, as suggested by Garcia (1992). The displacement of high-sulfur resid by natural gas in Mexico creates a sizable problem for Pemex, since high-sulfur resid is a major refining product and constitutes nearly all of the fuel use in Mexico's electric utility sector. The trade off between the two fuels for other industrial processes is more complicated. Fuel oil is typically used to initiate firing in industrial boilers and natural gas to maintain firing. When natural gas is scarce or expensive, fuel oil is used solely, but with higher maintenance costs which must be considered when evaluating gas prices relative to fuel oil prices for industrial consumption. In contrast, electric boilers have provided a secure market for Mexico's high-sulfur residual oil. In both cases, once firms are equipped to burn natural gas (given environmental concerns and regulations) and if this capacity is dual-fired, firms will react most rapidly to changes in price. We analyze later, in more detail, the residual oil constraint on development of Mexico's natural gas market and options being weighed by Pemex to resolve the dilemma created by possible displacement of residual oil by natural gas.

### Regional Natural Gas Consumption Patterns

To the extent that the economic outlook for Mexico remains positive, aggregate demand for gas should continue to grow. We turn now to the question of how regional patterns of natural gas consumption in Mexico have contributed to the pattern of gas flows into Mexico in recent years.

Mexico's gas industry is characterized by a strong north-south division. Gas is largely produced to the south, but infrastructure to move gas northward is limited even while growth in demand in the northern states has been quite vigorous. Thus, it is the northern states in Mexico, and principally the state of Nuevo Leon, that are being served most by imports of gas at this time. The state of Nuevo Leon, in particular, boasts a rapidly growing economy, one that has always maintained a more open relationship with its northern neighbor. The states of Nuevo Leon, Tamaulipas, and Coahuila contribute more than 11% of Mexico's total gross domestic output, with Nuevo Leon's share alone comprising 6%. Nuevo Leon and the metropolitan area of Monterrey hold the largest share of heavy and advanced industry and commercial and professional services in northeastern Mexico (Garcia, 1992). Natural gas figures prominently in Nuevo

3. These early observations may stem from problems in model specification.

Leon's fuel mix, where it is used most often in industrial processes, especially petrochemicals production. Natural gas consumption in Nuevo Leon is expected to increase 2.8% per year on average to the year 2000 (Garcia, 1992).

In spite of strong gas demand growth in northern Mexico, the gas transmission infrastructure in Mexico constrains the northward movement of gas from Mexico's principal producing basins in the southeast and offshore. A single, 40-inch-plus, north-south line was constructed in the 1970s to bring gas to the United States. Now, Mexico City and central Mexico take much of what would have been transported on this line.

## SUPPLY OF NATURAL GAS IN MEXICO

As we illustrated in Figure 2, Mexico produced about 3.6 Bcf/d of natural gas in 1992, which falls short of the approximately 4 Bcf/d of total consumption. Three factors affect natural gas supply in Mexico: (1) development of Mexico's petroleum sector; (2) the geographic distribution and geologic nature of reserves in Mexico; and (3) availability of natural gas for export to Mexico.

### Development of Mexico's Petroleum Sector

Natural gas production in Mexico has been heavily impacted by declining investment in Mexico's petroleum sector and the reorganization of Pemex, which has both positive and negative ramifications for domestic supply.

### *Investment in the Natural Gas Industry*

Pemex controls all phases of the natural gas industry in Mexico, from exploration and production to transmission. The problem for Mexico of increasing domestic gas production to meet incremental demand is exacerbated by the financial constraints that Pemex has faced in recent years, and probably will continue to face in the foreseeable future. In 1983, Pemex's total capital investment, including petrochemicals, was 94.1 billion 1980 pesos. Between 1983 and 1991, investment declined to 53.3 billion 1980 pesos.<sup>4</sup> Exploration and development drilling in Mexico fell dramatically as world oil prices declined in the 1980s (Figure 4). Gas wells constituted only about 10% of exploration and development wells drilled in 1991, although drilling for gas was almost double the previous years' activity. While the data in Figure 4 show drilling

4. See Garcia (1992); data from Pemex and Bank of Mexico.

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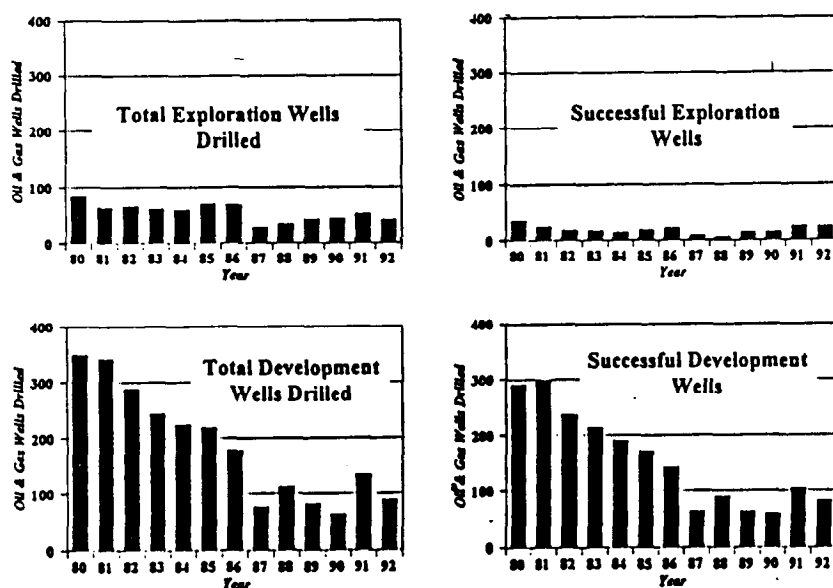
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Figure 4. Drilling in Mexico 1983-1991



Source: Pemex

activity has recovered, the principal consideration for Pemex is funding new drilling programs in addition to improving and expanding other upstream and downstream needs.

In 1991, Pemex announced a five-year, \$19-billion program for upstream and downstream activity for both oil and gas (excluding petrochemicals). Of this amount, \$10 billion was targeted from cash flow and \$9 billion from debt, most of which is to be placed overseas even though borrowing abroad has met with resistance in Mexico (*International Petroleum Finance*, 1991). E&P expenditures will be \$13.9 billion from 1993 through 1997.<sup>5</sup> Pemex plans to fund its capital expenditure program, in part, with a \$1.3 billion credit line from the U.S. Export-Import Bank. These loans are targeted for purchases of U.S. oil and gas equipment and related services. The program could expand to a \$6 billion loan guarantee, which would represent 75% of the investment capital Pemex estimates it will need from foreign sources (U.S. GAO, 1992). However, Pemex recently requested that the Export-Import Bank

5. Comment from George Baker, Baker & Associates.

cancel part of the loan package. The loan package was to fund offshore exploration and production activity at Zaap, Maloob, and Campeche.<sup>6</sup>

Pemex also is raising its new capital through bond placements in foreign markets. The elimination of \$7 billion in external debt through government recapitalization enabled Pemex in to re-enter the world capital market in 1990. It had been excluded from this market for eight years as a result of Mexico's financial crisis (U.S. GAO, 1992). Achieving these investment goals is problematic, however. The Pemex operating budget is approved on an annual basis, and is subject to Mexico's fiscal needs and balances; Pemex provides a third of Mexico's total government revenues. Investment authorizations have been short of Pemex's objectives as set forth in its five-year investment plan (U.S. GAO, 1992).

In addition to crude oil production and refining, Pemex's capital expenditure program will focus on natural gas, including improvements in natural gas transmission. Details of this portion of the capital expenditure program are not widely known. Because of Pemex's focus on crude oil production for export, however, investment in natural gas production is expected to be slow-paced.<sup>7</sup>

Petrochemicals are another area of focus. Pemex controls most of the petrochemicals industry, which relies on gas for 80% of its feedstocks and which has experienced similar declines in capital spending. Petrochemicals consists of two groups of products, basic and secondary. Historically, all basic products, which include ethylene and propylene, were reserved for Pemex. The number of basic products reserved to Pemex was reduced from 70 to 34 in 1986, and then to 20 in 1989. With passage of the NAFTA, a further reduction to 5 will take place. "Secondary" petrochemicals are all products not identified as basic petrochemicals, and are not solely controlled by Pemex. With the NAFTA, foreign investment in all secondary and the unreserved basic products will be allowed to rise from 40% to 100%.<sup>8</sup>

6. See *Oil and Gas Journal "Newsletter"*, September 28, 1992 and *El Financiero Internacional*, November 16, 1992; comments from George Baker.

7. Comments from Pemex authorities indicate that the priority at Pemex is to develop gas reserves and search for more gas in northern and southwestern Mexico. Capital constraints for gas are, as Pemex's export strategies imply, more constrained. New financial schemes being developed at Pemex may alleviate these constraints, but private financing would make the biggest difference. Comments from industry experts suggests that Pemex is already producing more gas from its northern zones, and is conducting technical surveys with some participation by U.S. companies.

8. Information on the changing petrochemicals product designations from *Latin America Monitor*, May 1991, "Petrochemicals Deregulation Likely." This and all subsequent analyses of the NAFTA provisions are taken from a summary of the agreement prepared by the U.S. Trade Representative's office and details from the draft agreement; an in-house review prepared by Akin, Gump, Hauer & Feld; an analysis of the NAFTA by the Industry Sector Advisory Committee on Energy for Trade Policy Matters (ISAC-6); and comments from industry and legal experts.

Between 1980 and 1987, basic petrochemicals investment in Mexico fell from approximately \$800 million to less than \$300 million in 1980 dollars. Secondary petrochemicals investment dropped from more than \$900 million in 1981 to roughly \$50 million in 1987 (U.S. GAO, 1991). Pemex does not have adequate capacity to meet basic petrochemical product needs in Mexico, and so must import significant volumes. The value of these imports in 1988 was approximately \$1.2 billion. Between 1980 and 1988, Mexico spent about \$5.5 billion on basic petrochemical product imports, a figure that could rise to \$8.6 billion by 1995 (U.S. GAO, 1991). Importantly, Pemex is launching a fairly aggressive privatization program with the sale of a number of petrochemical plants. Depending on its success, Pemex's investment needs in this area could be reduced.<sup>9</sup>

From the information we have compiled here, it should be obvious that legal and institutional modifications must continue to occur for Pemex to secure financial resources from abroad. An analysis of changes in the Mexican institutional framework is required to forecast the long-run prospects for natural gas imports by Mexico.

### *The Reorganization of Pemex*

Pemex controls exploration and production activities, transmission of gas and gas liquids as well as oil and refined products, and refining and petrochemical operations. It also controls, through its international trading subsidiary, *Petroleos Mexicanos Internacional* (PMI), crude oil and products trading. While Pemex has been widely criticized for much of what ails Mexico's energy sector, it is important to remember that Pemex itself is subject to great uncertainty given its importance to Mexico and the amount of control exerted over Pemex by the Mexican government.

As described earlier, Pemex's operating budget is established by government mandate in light of Mexico's fiscal situation each year. Historically, Pemex has relinquished the bulk of its profits directly to the government, with little left for reinvestment. In late 1992, Pemex announced that this would no longer be the case, and that it would pay taxes to the government much like a private corporation and allocate after-tax profits accordingly. A series of reforms put into place by the Salinas administration is imposing fundamental changes in how Pemex operates, such that some view the evolution of Pemex to that of a

9. Comments from Francisco Garcia and Rafael Quijano, The Petroleum Finance Company.

private entity as inevitable.<sup>10</sup> The cost of these reforms has been high—job reductions at Pemex are estimated to be 150,000—and many of the ancillary services Pemex provided (such as hospitals) are being eliminated or curtailed.

Spurred by the tragic explosions in Guadalajara, the NAFTA negotiations, and mounting investment and infrastructure needs, Pemex instituted in 1992 a reorganization plan that created four domestic operating subsidiaries (Figure 5). Of note is the move to emphasize gas by establishing the Gas and Basic Petrochemicals group. Natural gas trading activities were relocated from PMI to Gas and Basic Petrochemicals. One consideration in this reorganization plan is the control over gas production and use that will be exerted by Pemex's downstream business. Two other features of the reorganization plan stand out. One is the poorly defined linkage between the Energy Ministry (Ministry of Energy, Mines and State Industry or SEMIP) and Pemex, and the lack of integration between the Energy Ministry and Economic Cabinet. The other is the poorly defined linkage between PMI and the four subsidiary companies. Nevertheless, the new Pemex offers great potential for increased efficiencies and reinvigoration of Mexico's energy sector, as well as the elevation of natural gas to its proper position as a critical resource for the country.<sup>11</sup> As with all things of this nature, however, natural gas production in Mexico is likely to suffer until the Pemex reorganization is fully implemented and the capital funding campaign has progressed.

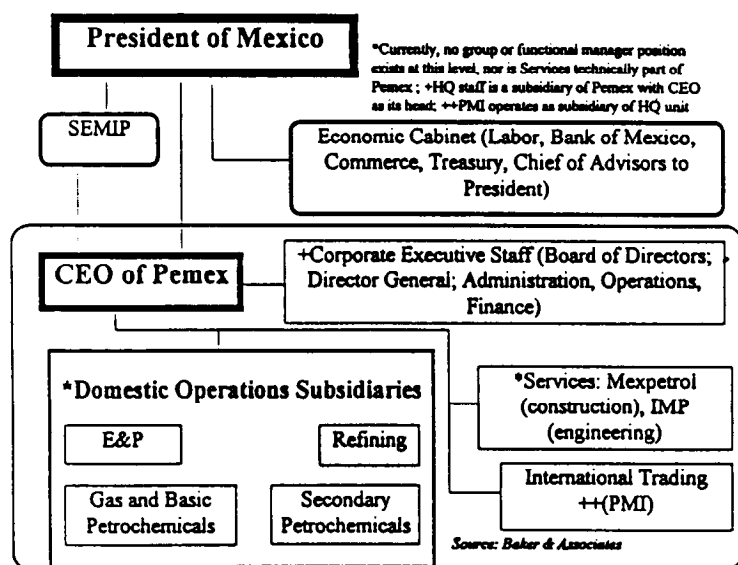
### Geographic Location and Geologic Nature of Mexico's Reserves

The location and characteristics of Mexico's natural gas reserves pose two problems. One lies in the difficulty in serving gas users in Mexico's northern states. We noted earlier that while aggregate demand for gas in Mexico has increased, demand for gas in northern Mexico has grown particularly rapidly. However, Mexico's transmission system constrains the northward flow of gas. Natural gas exports to Mexico have flowed into this gap. The pipeline system reflects the distribution of gas reserves in Mexico, and expansion of transmission capacity in Mexico would alleviate gas shortages in the north.

10. See, for example, "Tax Changes for Mexican Oil Company," *Financial Times*, November 11, 1992; comments from Rafael Quijano. In a December 1992 circular (No. 923) the Heritage Foundation also makes the provocative point that privatization of Pemex does not imply foreign participation.

11. Comments from Pemex authorities on the reorganization are that participation by SEMIP with Pemex will increase; that the appointment of Emilio Lozoya Thalmann to secretary of SEMIP in January 1993 should speed up liberalization of the energy sector; and that a goal for the new Pemex business units is to establish contractual relationships with the CFE.

Figure 5. Pemex Organizational Structure

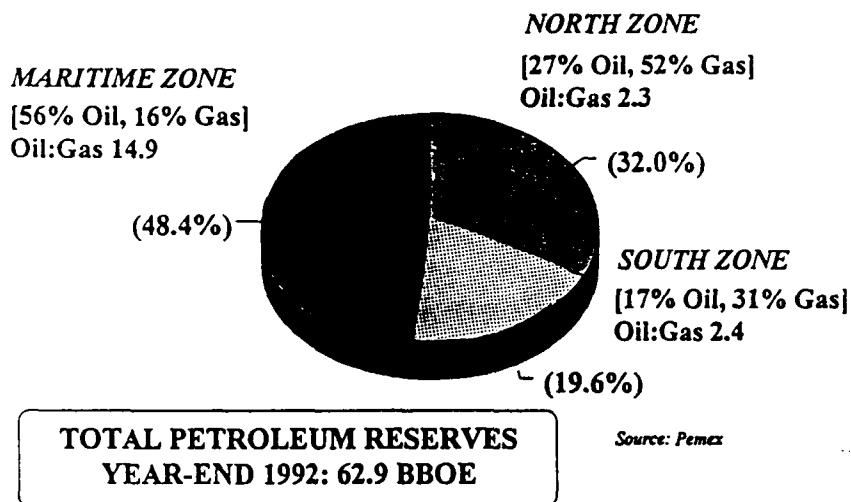


The second, more serious, problem for Mexico lies in the geologic attributes of its gas reserves. The bulk of oil production in Mexico is from the maritime region; Reforma-Campeche provides 46.5% of Mexican production. These reserves also have the lowest gas-to-oil ratio (Figure 6; data include the Chicontepec Basin). Thus, most of the gas produced from Mexico's southern and offshore basins is associated with crude oil. Foss and Johnson (1991) gave considerable attention to the problem of non-associated gas in Mexico and its role in gas resource development.

Currently, about 90% of Mexico's production of natural gas is associated with crude oil production, and therefore must be produced if crude oil exports are to remain at relatively high levels. This compares to a ratio for associated gas of 35% of production in 1970. While most of Mexico's gas reserves also are located in the south and maritime zones, these areas actually produce proportionately less gas because of the lower occurrence of associated gas, principally in offshore fields in Reforma-Campeche. Some experts have suggested that because of these characteristics, the shift in emphasis to drilling for oil by Pemex in the more prolific offshore areas in order to maximize crude oil exports could result in less production of associated gas over time, reducing the amount of total gas produced and available for domestic consumption and, thus, preserving the need for gas imports. Indeed, offshore oil production has steadily increased since 1981, while production from the southern and northern basins declined (Garcia, 1992). Other analysts differ with this scenario based on



Figure 6. Petroleum Reserves in Mexico (zones as % of total)



evidence that significant non-associated gas discoveries have been made offshore. These analysts contend that because attempts in the 1970s to form an export agreement with the United States were unsuccessful, and because budget constraints were later imposed on Pemex, offshore discoveries of non-associated gas have not been developed but could be exploited relatively easily.<sup>12</sup>

Should production shortfalls of gas occur as a result of the emphasis on offshore oil development, Pemex would be faced then with either increasing imports or funding development activity in the gas-rich northern basins, where gas is not only more abundant but also occurs largely non-associated with oil. Such a decision would seem to be subject to the overall capital spending program Pemex has devised and the difficulties inherent in financing petroleum development in Mexico.

12. The widely debated issue of whether the geologic occurrence of natural gas in Mexico poses the longer term constraint that seems apparent was discussed with an array of industry experts. See Foss and Johnson, 1991 for more details. Since publication of the 1991 paper, this issue has been discussed with managers at Pemex but remains unresolved. Authorities at Pemex, however, seem less concerned about the question of associated/non-associated gas than do observers in the U.S. and Canada.

### **Availability of Natural Gas for Import by Mexico**

If Mexico continues to import natural gas over the longer term, what are the primary factors influencing the availability of this gas? Here, we identify several considerations, including surplus deliverability in North America, perceptions (real and imagined) about the reliability of supply and price stability of U.S. gas, the role of Canadian gas, and pipeline systems to transport gas to Mexico.

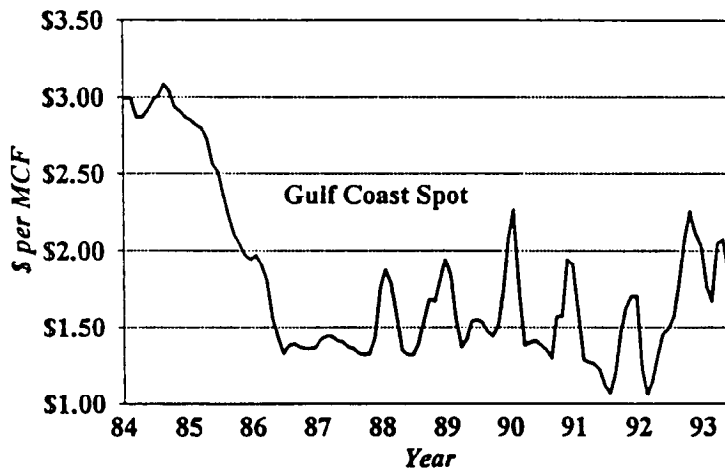
### ***Price, Supply, and Reliability of U.S. Gas***

Whether Mexico will continue to buy natural gas from the United States will depend on its price. Until March 1992, the spot price for U.S. natural gas was sinking to ever lower levels because of the persistent U.S. gas "bubble" or surplus of deliverability (Figure 7). This began to change in January 1992 when the average monthly U.S. spot price on the Gulf of Mexico started rising from a low of about \$1.05 per MMBtu to a high of about \$2.25 per MMBtu in October 1992. After a drop in late 1992, prices edged up again in 1993. These short-term movements in price are a reflection of individual and, to some extent, unique events, including the abnormally cold weather late in the 1993 heating season.

Of more interest to us here are the longer term movements in U.S. gas prices. The 1992-93 spike in natural gas prices has rekindled some concerns in Mexico that one cannot depend on stability in either the price or the supply of U.S. natural gas. In fact, there are several reasons why natural gas is likely to continue selling at favorable prices relative to oil for the rest of this century.

1. There has been a substantial addition to pipeline capacity in the United States which has opened several areas to exploration and production. The most important areas in which there have been major reserve additions are the San Juan and other basins in the Rocky Mountains and the Arkoma Basin, which straddles the boundary between Arkansas and Oklahoma.
2. The construction of pipeline laterals and interconnections has enabled the movement of gas to almost all parts of the United States.
3. Although measures of exploration activity, such as working seismic crews and drilling rigs, are down, the U.S. industry has increased substantially its productivity in exploration through improved technologies. Reserves of natural gas have remained more or less stable over the last 10 to 20 years.

Figure 7. U.S. Natural Gas Prices 1984-1993



*Source: Jofree Corporation; straight average of Texas Gulf Coast onshore and offshore, Central Texas, West Texas, Anadarko, Louisiana Gulf Coast onshore and offshore, and North Louisiana*

4. Canadian gas penetration into U.S. markets should increase with the completion in a year or two of several major pipeline projects that will expand deliveries of Canadian gas. In effect, Canada's large reserve base should now be added to U.S. reserves and, because of this, considerable downward pressure on prices is possible, particularly if Canadian deliverability is increased.
5. Open transportation on U.S. natural gas pipelines has been implemented. As a result, there is now significantly greater competition in the U.S. market and, because of this, downward pressure on delivered prices for natural gas.
6. In 1980, the U.S. government enacted the so-called Section 29 tax credit program in an effort to encourage development of various high cost sources of energy, including coal bed methane and tight sands gas. The deadline for the spudding of qualifying wells was December 31, 1992. However, production from qualified wells will continue to receive the credit until year-end 2002. As of January 1, 1993 the tax credit for tight sands gas was \$0.52 per MMBtu, while the tax credit for coal bed methane was \$0.98 per MMBtu. These credits are significant, even when compared to an average annual wellhead price for natural gas of around \$2.00 per MMBtu. In 1992, close to half of

all wells drilled in the United States were drilled to qualify for the tax credit. Most of these wells are in the San Juan Basin of New Mexico and other basins in the Rocky Mountains. Production of natural gas from these wells is expected to peak in or around 1998. This production will tend to depress the wellhead price for U.S. gas because the tax credit is a subsidy and, like all other subsidies, will tend to encourage additional production.

7. In addition to the Section 29 tax credits for unconventional gas plays, elimination of the alternative minimum tax (AMT) as part of the recently passed U.S. Energy Policy Act of 1992 may serve to prolong lower gas prices by stimulating independent drilling activity in qualified wells.
8. Downward price pressure also comes from regional market trends. Because of increased exploration, production and pipeline construction in the Rockies, Rocky Mountain gas is now backing West Texas gas out of California. As a result, Texas gas is expected to replace Rocky Mountain gas as the lowest priced gas in the U.S. Competition with Canadian gas in the California market will increase with the completion of Pacific Gas Transmission's expansion in November 1993. Canadian gas shipped into California on this line will also back Texas and Oklahoma gas out of California markets, putting downward pressure on the price of gas. Because Gulf Coast gas comprises a large proportion of what Mexico imports from the United States, these trends should serve to reinforce the advantage Gulf Coast production has in the northern Mexico market.

For all of these reasons, Mexico should have a price incentive to continue purchasing U.S. natural gas for some time to come.

### *The Role of Canadian Gas*

The United States has, of course, taken imports of Canadian gas for more than 30 years. The government of Canada relaxed gas export restrictions and U.S.-Canadian gas trade is now quite open. Canadian pipeline exports to the United States increased rapidly after 1986, when Canada allowed exporters to charge prices that made Canadian gas competitive in the U.S. market. Canada supplied 2 Tcf of gas to the United States in 1992 or roughly 10% of U.S. total supply, with 41% going to the central United States, 23% to California, 21% to the Northeast, and 13% to the Pacific Northwest. Canadian exports should

account for almost 12% of total U.S. consumption of 21-24 Tcf in the year 2000 (Fredette, 1992). Gas trade between Canada and the United States also is entrenched by the Free Trade Agreement (FTA) between these countries, irrespective of the ultimate fate of the NAFTA.

Canada, with its sizable proven reserves of gas in the Western Sedimentary Basin, has come to play an important and highly competitive role in the gas import market in Mexico, albeit via backhauling Canadian gas into the United States to make up for U.S. exports to Mexico. Discussion of Canadian gas flows to Mexico have centered on gas outflows from California, which, as we discuss above, is the recipient of large pipeline capacity expansions planned to move additional Canadian gas to the United States. At one time, Canadian companies figured importantly in a coalition bidding on a major electrical generation project planned in northwestern Mexico. Tightened deliverability in Alberta during the winter of 1992-93 and growing doubts about the adequacy of proven reserves in Canada have reduced the likelihood of Canadian gas directly entering the Mexican gas market.

Another consideration for Canadian gas is the resumption of Mexican exports to the U.S. market, in which Canada is now unchallenged. Energy, Mines and Resources Canada (EMR) views Mexico as a "sleeping giant" with respect to gas production potential (Foran, 1991), and many Canadian gas industry analysts envision head-to-head competition with Mexican gas in key U.S. markets. The question of when, and at what volumes, Mexican exports would resume is the focus of much attention in Canada. So, too, is the issue of whether Mexico will be exporting from a "level playing field" through an open, deregulated, competitive energy sector.

### *Natural Gas Pipeline Systems to Mexico*

A consideration in the availability of gas for import by Mexico is cross-border transmission capacity. The past two years saw a flurry of cross-border activity, but higher U.S. prices, slower economic growth in Mexico, greater availability of gas production in Mexico, and other factors have combined to delay several proposed projects. Gas is being sold to Pemex by a number of U.S. companies, including major and independent producers, pipeline affiliates, and independent marketers. In addition, Canadian companies entered the market with shipments of 10 MMcf/d of gas to Pemex in October 1992 by Western Gas Marketing Ltd., a unit of TransCanada. Western Gas is using Valero's new pipeline interconnect from Penitas, Texas to Reynosa, Tamaulipas, which adds 400 MMcf/d of capacity across the Texas border. Prior to this pipeline addition, the existing interconnects were: Texas Eastern's (TETCO's) 350 MMcf/d line from McAllen, Texas to Reynosa (on which capacity could be increased to 1.0 Bcf/d); El Paso's 35 MMcf/d line which enters at Naco, Sonora; three lines

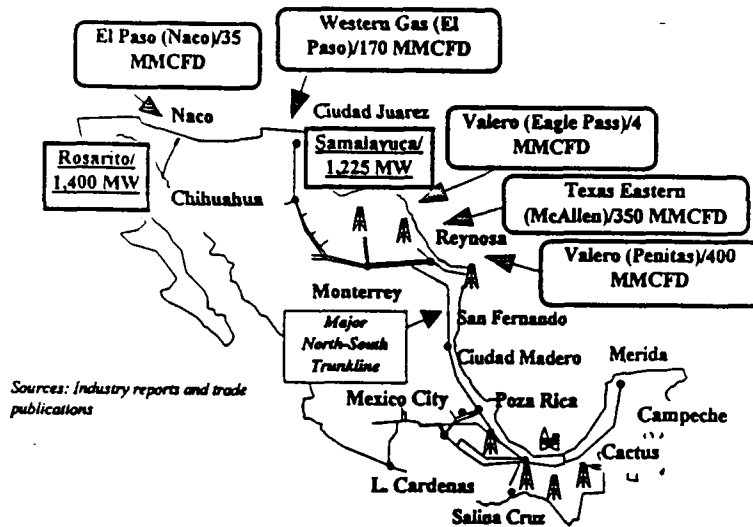
operated by Western Gas Interstate crossing at El Paso with a total capacity of 170 MMcf/d; and Valero's original 4 MMcf/d line from Eagle Pass, Texas, to Piedras Negras, Coahuila (see Figure 8).

A number of projects have been proposed, including the much discussed electric power generation conversions and expansions in Samalayuca, Chihuahua just south of Juarez (with an interconnect from El Paso's pipeline in Waha, Texas) and Rosarito, in Baja California Norte just outside of Tijuana (with an interconnect from El Paso's pipeline in Ehrenburg, Arizona). The Samalayuca project, which could add an initial 450 MMcf/d of new cross-border gas transmission capacity, has been awarded to a consortium consisting of Coastal, GE, and El Paso, with a year to execute the final agreement. As of this writing, there is some discussion about delaying conversion of fuel oil-fired capacity at Samalayuca to gas. Southern California Gas Co. (SoCalGas) and San Diego Gas & Electric (SDG&E) are considering delivery of gas to the Rosarito plant possibly in a swap for electricity. The SoCalGas/SDG&E project would add 300-500 MMcf/d of capacity originating in San Diego, California. SoCalGas/SDG&E are competing with El Paso. (Tennessee Gas also had submitted a proposal.) The Tri-National consortium (with U.S., Mexican, and Canadian participants) had been favored for Rosarito, but the project will be out for re-bidding at some point in the future. Two cross-border pipeline projects have been proposed. Houston Pipe Line (HPL) applied with the U.S. Federal Energy Regulatory Commission (FERC) to construct a 600 MMcf/d interconnect out of McAllen. ENSA proposed and applied for a 500 MMcf/d line out of Laredo, Texas. Apart from these projects, Protexa, a Mexican oil service company, has proposed a pipeline from Laredo to Monterrey. Many U.S. and Canadian firms have been exploring pipeline expansions primarily for electric power generation, and investigating the prospects for co-generation and independent power projects. These projects may benefit from the NAFTA accords, a point addressed later.<sup>13</sup> Gas storage expansion, greatly needed in Mexico, also is being considered either as part of the projects we describe or separately, with the most likely scenario being development of storage in the United States to provide as a service to Pemex.

If all of these proposed projects are completed at their initial capacities, the transmission potential would increase from almost 960 MMcf/d to nearly 2,250 MMcf/d. This estimate assumes expansion on TETCO's line, Rosarito going forward, and original specifications for the Samalayuca project being retained. The probability of all projects moving forward is low. HPL's project

13. Information on cross-border capacity comes from a variety of sources, including the *Oil and Gas Journal*; *Inside FERC*; Energy, Mines and Resources Canada; Cambridge Energy Research Associates; and conversations with industry experts. Comments from Pemex authorities are that budget constraints in Mexico may slow the development of Samalayuca and Rosarito.

Figure 8. Cross-Border Gas Transmission to Mexico



Sources: Industry reports and trade publications

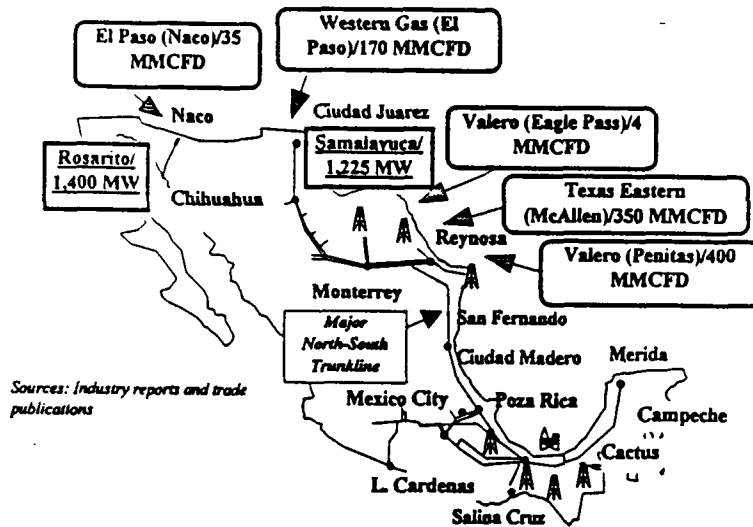
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## POLITICAL ISSUES

Analysis of longer term prospects for the Mexican natural gas market, and its position in the North American market, cannot rest on economic analysis and logic alone. As the NAFTA negotiations progressed in 1992, and as the changes at Pemex unfolded, the unique political nature of Mexico and political relationships among the three countries moved to the forefront. Several considerations serve to moderate conclusions drawn from the analysis to this point.

One consideration is the willingness on the part of Pemex to accept competition in its own gas markets. Protection of monopoly markets is viewed by U.S. and Canadian interests to be a source of market failure in Mexico's energy sector. In Mexico, it is a right and a privilege backed by the

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Constitution.<sup>14</sup> Another consideration is Mexico's stance regarding current as well as future reforms in its petroleum sector. A third consideration is the impact of the NAFTA. It should be evident to the reader that the NAFTA essentially builds on trends and changes already taking place in North America that bear strong implications for natural gas. Provisions in NAFTA that may directly impact gas markets follow. Many shortcomings in the agreement exist, and these are mentioned as well.

1. While gas pipelines and transportation remain under Mexican state control, state enterprises, end users, and gas suppliers in the NAFTA countries can negotiate direct sales of gas to consumers. However, the Mexican government has the right to be included in contract negotiations, and in the language of the agreement may have the right to refuse to agree to a contract, thereby effectively vetoing a purchase or sales agreement.
2. Foreign participation will be allowed in co-generation and independent power production (IPP) projects in Mexico. Excess power produced from co-generation and all power produced by IPP projects for sale in Mexico must be sold to the CFE. If an IPP project in Mexico wishes to sell electricity cross-border, it must negotiate with the CFE to do so.
3. While Pemex retains all control of petroleum exploration, production, refining and processing, Mexico is required to allow, but not required to negotiate, performance contracts with energy service providers, such that a provider can receive increased payments based on success. In addition, Mexico is required immediately to apply open, competitive procurement procedures to 50% of all purchases by Pemex and the CFE valued above \$50,000. The 50% ceiling will be phased out gradually over 10 years. While the phase-out period is longer than some in the oil service industry had hoped, by the end of the period oil service providers can look forward to open bidding for 100% of Pemex and CFE procurement.
4. As already stated, in recent years Mexico has aggressively reduced the number of basic petrochemicals reserved for Pemex, and the NAFTA further reduces this number to five products from the 19 which are currently excluded. The NAFTA requires that Mexico allow 100% foreign investment in 14 of the 19 basic petrochemicals and all 66 of

14. Refer to "Mexico's Economic Reform: Energy and the Constitution" by Luis Rubio, elsewhere in this volume.

secondary petrochemicals, in which foreign investment is currently restricted to 40%. Critically, however, Pemex retains control over the most valuable products.

5. A controversial initiative in the NAFTA is the emergency supply provision. The Canada-U.S. Free Trade Agreement (FTA) contains a provision that limits each jurisdiction's ability to intervene in the market on national security grounds. At the time of negotiation and approval of the FTA, this was a point of dispute especially for Canada. Canada and the United States agreed to continue this provision in the NAFTA. The NAFTA states that when any jurisdiction imposes a supply restriction (which can only be imposed under very specific circumstances, such as to conserve exhaustible resources, deal with a short supply situation, or to implement a price stabilization plan), it must not reduce the proportion of total supply made available to other NAFTA countries below the level of the preceding three years or some other agreed upon period. Also, the jurisdiction cannot impose a price on exports to another NAFTA country that is higher than the domestic price or require disruption of normal supply channels. Mexico did not accept these commitments but did agree to abide by GATT trade obligations and to avoid the use of export taxes as a trade measure. The NAFTA also contains clauses to the effect that energy regulatory measures are subject to the agreement's general rules regarding national treatment, import and export restrictions, and export taxes. Finally, all countries must pursue regulatory measures that reflect the importance of a stable regulatory environment.

The emergency supply provision is very important to Mexican policy makers. Investing in natural gas exploration and production alone does not make sense in economic terms if it is possible to invest in E&P for crude oil and, with a small fraction of the value of crude exports, pay the cost of importing natural gas. If Pemex were to decide to satisfy the total domestic demand for natural gas in Mexico, the level of investment in crude oil production would be considerable given the characteristics of natural gas occurrence. In addition, a high percentage of this "extra" crude would have to be exported, mainly to the United States. This supports the hypothesis that the United States and Canada will put pressure on Mexico to accept the emergency supply provision. The consequence of all of this is that Mexico would be exporting oil when higher

value manufactured goods should be developed and exported in order to promote a higher level of economic development.<sup>15</sup>

All of the measures cited here could enhance the use of natural gas in the NAFTA countries as well as promote cross-border trade and increased efficiency in energy development and energy markets. The NAFTA still preserves some imbalances in energy, especially with regard to the relative openness of each country to outside investment. The United States is most open, while Canada maintains some restrictions (such as investment screening for large acquisitions), and Mexico is still fundamentally closed. Market distortions in the energy sector will persist under the NAFTA, so that many observers feel that continued negotiation will be required even after approval and implementation. In Mexico, important steps will be taken under the NAFTA, especially with regard to direct sales of gas, co-gen and IPP opportunities, and performance contracts which could eventually lead to risk sharing ventures upstream. Growth in co-gen and IPP will be an important source of demand for natural gas suppliers. If patterns in the United States are any indication, natural gas use for these projects in Mexico will be high; in the United States, gas fuels almost 50% of non-utility electric power generation. We must emphasize again, however, that the NAFTA is filled with caveats, its implementation will unfold over several years, and these draft provisions cannot be taken as guaranteed. The Clinton administration may also want to renegotiate some provisions as well. In addition, as of this writing, the NAFTA faces some downside risk, given a U.S. federal court ruling that an environmental impact study must be prepared.

The NAFTA also contains some important provisions for coal in Mexico which could increase gas-coal competition in that country. Under the NAFTA, coal tariffs in Mexico go from 10% to zero immediately upon implementation. Tariffs on natural gas do not change. The NAFTA eliminates discrimination between domestic and imported coal in the application of the 6% value added tax on shipments to state-owned enterprises; guarantees national treatment for U.S. imported coal; removes Mexico's 49% limit on U.S. equity ownership in new Mexican coal mines and facilities, while retaining the 49% limit for existing facilities for three years from date of sale; provides operating and management protection rights for U.S. investors in coal mining, processing, and use facilities; limits the use of import and export restrictions to maintain monopoly markets for competing energy fuels; and restricts the use of regulatory

15. Comments from Pemex authorities are that the emergency supply provision was originally viewed to be a door to intervention in Mexican energy policy. Views now are that the provision would not have much effect, in light of Mexico's voluntary cooperation with the United States by increasing oil exports during the Gulf War. For more details on these aspects of the agreement, refer to Campbell Watkins, 1993, "The NAFTA and Energy: A Bridge Not Far Enough?" in *Assessing NAFTA: A Trinational Analysis*, (S. Globerman and M. Walker, eds.), Fraser Institute: Vancouver.

measures for discriminating between domestic and U.S. coal and competing energy goods.<sup>16</sup>

The immediate advantages to imported coal probably reflect Mexico's lower resource base with which imports would compete. This is in stark contrast to gas. The importance of these clauses lies mainly in electric power production. Of the already mentioned 6,500 MW in new capacity planned by the CFE, about 2,000 MW is slated for coal. Much of the new capacity targeted by the CFE will be built on the Mexican coasts, so that water transport of coal will be highly feasible. Apart from new capacity, favorable treatment for coal will be a disincentive for the CFE to convert existing coal-fired units to gas, and an incentive to build new coal-fired plants (three are currently under construction). One estimate of Mexico's coal needs is 22 million tons by early next decade. Competition with U.S. coal has already become evident. Colombia and Venezuela are vying for east coast markets in Mexico, while Australia has expressed interest in serving west coast markets in Mexico, although ocean freight rates may limit the economics of Australian coal purchases. Western U.S. coal has been most closely evaluated by the CFE, but eastern U.S. coal shipped through New Orleans is also a viable option. As with the gas transmission infrastructure in Mexico, the rail system would need considerable upgrading to be compatible with U.S. rail transport for substantial coal import deliveries.<sup>17</sup>

The most obvious indirect effects of the NAFTA for natural gas are the environmental provisions which, although with regulatory flexibility within each jurisdiction, commit the signatories to pursue high standards, cooperate on environmental protection, and seek dispute resolution through NAFTA panels if so desired.<sup>18</sup> As an example of how this could work, a private IPP could come under scrutiny under the NAFTA, leading to decisions on fuel supply based on air emissions, with gas presumably favored. More important than the NAFTA environmental provisions will be the attitude of the Clinton administration and negotiations on provisions outside of the current text in order to ensure ratification. The prevailing opinion is that the main effort of the Clinton administration will be to "de-politicize" environmental and labor issues surrounding the NAFTA and stimulate a search for constructive solutions leading to quick ratification.<sup>19</sup> Other indirect ramifications of the NAFTA for gas include improved access for Mexico to foreign capital markets, which have policy implications for gas supply.

16. ISAC-6 (see footnote 8).

17. Comments from Moya Phillips, U.S. Coal Exporter's Association; Rafael Quijano; and contacts at Pemex.

18. U.S. Trade Representative summary of the NAFTA.

19. Comment by Mont Hoyt, Verner & Lipfert.

The NAFTA has generally been viewed as an essential agreement for the preservation of the reforms and initiatives begun during the Salinas administration. More controversial is the role of the NAFTA in forcing democratic reforms in Mexico. Expectations in the United States, Canada, and Europe of political reforms and open elections in Mexico are high. In part, this may be due to the stance taken by the United States at the beginning of negotiations, namely, the view that the NAFTA was a political document rather than an economic one.<sup>20</sup>

#### **SUMMARY: THE BASIS FOR LONG-TERM EXPORTS OF GAS TO MEXICO**

We have argued that prices of U.S. gas, proximity of Mexico's northern markets to U.S. supply, the nature of Mexico's gas transmission infrastructure and distribution of gas reserves, and Pemex's capital constraints all contribute to favorable conditions for continued imports of natural gas by Mexico. The NAFTA should act to reinforce these positive forces. Caution must be taken against reading too much into a new trade regime that carries some policy risk. We have already raised the importance of environmental issues in creating a favorable opportunity for gas. In Mexico, air quality concerns are becoming a primary influence on fuel choices. The extent of air quality degradation in Mexico was highlighted by the severe, hazardous pollution experienced in Mexico City in April, 1992 which forced a virtual shut down of parts of the metropolitan area. It should be noted that in addition to air quality concerns stemming from stationary sources, especially heavy fuel oil-fired industrial and electric utility boilers, Mexico has also explored vigorously the use of compressed natural gas in transportation. The *Instituto Mexicano del Petroleo* (IMP) has been engaged in considerable emissions testing of converted vehicles as well as air quality monitoring and modeling<sup>21</sup>. Mexico has expressed an intention to have vehicular consumption of natural gas reach 90 MMcf/d in Mexico City by the mid-1990s.<sup>22</sup> Some experts feel that the transportation market for natural gas in Mexico City may be overstated, in spite of the allure of its huge size, given the problems associated with building

20. From an unpublished working paper on the NAFTA accord by Foss (1991) and comments provided by U.S. trade officials and analysts.

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infrastructure. A more likely scenario may be the emergence of a strong market in Monterrey, which now has a natural gas refueling site.<sup>23</sup>

An immediate solution to transportation emissions is to produce, or import, cleaner burning gasolines. For this reason, Pemex is planning new MTBE capacity. In a joint venture that may serve as a model for the future, Valero with Mexican and Spanish partners will build and operate a 13,000 b/d MTBE plant, with Pemex taking all of the output on long-term contract.<sup>24</sup> Because natural gas (methanol) is a feedstock for MTBE, capacity expansions and additions for MTBE will contribute to rising demand for natural gas.

As we noted at the outset, low gas prices in the United States may encourage Mexican gas imports. Factors which tend to depress U.S. gas prices will also tend to keep U.S. (and Canadian) gas competitive in Mexico over the longer term. Some arguments have been put forth that Mexico will remain a net importer of natural gas for the next 20 years.<sup>25</sup> Pemex officials who favor the import strategy generally maintain an outlook for net imports of about 10 years.<sup>26</sup> Our conclusion is that a 10- to 15-year time horizon is reasonable given the evidence at hand. But, lest we paint too rosy a picture, we raise some important caveats with implications for both the timing and pattern of U.S. and Canadian gas trade with Mexico.

## Constraints Concerning the Long-Term View

### *Mexico's Fuel Oil vs. the Natural Gas Challenge*

Up to this point, we have addressed the question of whether U.S. and Canadian gas exports to Mexico will continue over the long-term. A separate question is whether Mexico will allow import levels to increase. The answer depends, to a large extent, on the conversion of Mexico's electric utilities and non-petrochemical industries from high-sulfur residual oil to natural gas, largely to achieve improved air quality in Mexico's major urban areas. For natural gas to enjoy a secure and growing place in Mexico's fuel mix, a market must be found for Mexico's high-sulfur Maya crude. We raised this issue earlier and now address it in more detail.

Pemex's policy toward natural gas has been driven by Mexico's need to sell crude oil in export markets. A ready export market exists for Mexico's

23. Comment from Soll Sussman, Texas General Land Office.

24. *Oil & Gas Journal*, September 14, 1992 and comments from industry experts.

25. Comment from Thomas J. Woods, Gas Research Institute. The 1993 GRI baseline estimates Mexico to be a net importer for this duration.

26. Comments from experts at PMI.

relatively light Isthmus crude oil, but only a limited market for its heavy Maya crude. For this reason, Pemex has tried to refine as much Maya crude as possible. Mexican refineries are processing a mixture of about 60% Isthmus and 40% Maya. This mixture results in a straight distillation yield of about 30% to 40% high-sulfur residual oil. This fuel oil is, essentially, an unwanted by-product. A fundamental problem facing Pemex, therefore, is what to do with this resid.

In our analysis of natural gas demand in Mexico, we demonstrated that Pemex has sold its high-sulfur resid at bargain prices largely to dispose of the product and that, as a result, the price of Mexican resid is typically lower than the price of Mexican natural gas on a comparable Btu basis. A consequence of Pemex's pricing policy is that, since 1980, resid sales in Mexico have increased at a rate roughly equal to gas sales (Figure 9), largely because of the fuel oil's low price.

This has encouraged the CFE to burn fuel oil in most of its generating stations and many large industrial users to burn resid instead of natural gas. The position natural gas enjoys as a feedstock for petrochemicals is an added disincentive to non-petrochemical industrial end users to switch to gas. Importantly, until Pemex finds a market solution for its resid, any dramatic shift away from fuel oil for industry use will be problematic.

The ability of Pemex to place its high-sulfur resid in Mexico is highlighted by data on the national fuel mix. Table 2 shows energy use across different sectors expressed commonly in kilocalories. The immediate outlets for high-sulfur resid provided by electric power generation and non-petrochemical industries are clearly delineated.

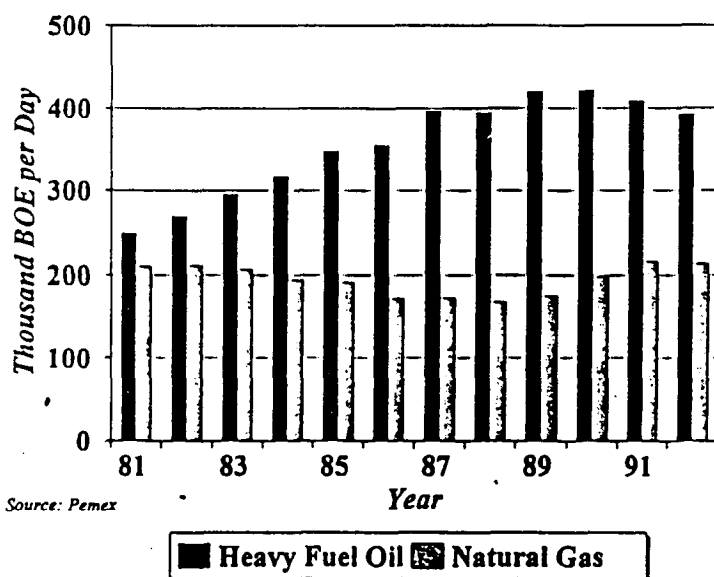
Table 2. 1991 Mexican Energy Use in Kilocalories

	Natural Gas	LPG	Fuel Oil	Other	Total
Power Generation	27.0	-	159.6	21.5*	208.1
Industry	125.4 <sup>b</sup>	3.6	72.0	90.6	291.6
Residential/ Commercial	8.2	59.8	8.6	28.9	105.5

Notes: \*Primarily coal; <sup>b</sup>Primarily petrochemical industries.  
Source: Ministry of State Energy, Mines and Industry (SEMIP)



Figure 9. Sales of Natural Gas and Heavy Fuel Oil in Mexico



Recall from previous discussion that only 11% of natural gas consumed in Mexico is for electric power generation, and that about half of the CFE's proposed new generating capacity is slated for natural gas while only 10% would use residual fuel oil. The potential for gas use in electric power generation in response to environmental concerns is substantial, especially in central Mexico and Mexico City where a number of fuel-oil-fired electric power units are concentrated, and along the Texas-Mexico border where growth in demand for electricity is expected to be very high. The problem of disposing of the displaced resid, however, is fully evident.

Export markets for heavy Mexican resid are virtually nonexistent. U.S. utilities and industrial users cannot burn it because of its high sulfur content. U.S. refineries cannot process it because of its high metals content. One solution to this problem for Pemex might be investment in coking, which can convert most of Mexico's resid into lighter refined products, such as gasoline, that are in greater demand in Mexico. By installing fluid coking, Pemex could convert its "bottom of the barrel" from resid to coke that would account for no more than four to five percent of Mexico's refinery yield. At the same time, Mexico's refineries could yield product slates that better fit demand for lighter refined products. Pemex could probably sell the high metal coke to the steel industry, where the presence of metals, especially vanadium, would be an advantage.

Investment in coking would be expensive. The cost of installing fluid cokers in Mexican refineries would be about \$10,000 per daily barrel of capacity or about \$250 million per refinery. Perhaps because of this cost, Pemex has no ongoing upgrading projects involving cokers.<sup>27</sup> Pemex is investing in viscosity breakers which are capable of reducing its refineries' output of residual fuel oil by about a third. Power plants and large industrial boilers that are fueled with the remaining high-sulfur resid may also be required to install scrubbers. Power plants and other large users of boiler fuel in Mexico could avoid investment in scrubbers if they choose to rely on natural gas.

Two recent projects suggest other possibilities that may be open to Pemex other than extensive investment in its own downstream facilities. One option is to take positions in foreign refining capacity. It was announced in August 1992 that Pemex was acquiring half of Shell's Deer Park refinery near Houston. This refinery has been running a relatively light crude oil purchased from Mexico. Under the new arrangement, the companies plan to add coking capacity that will enable the refinery to process heavy Maya crude. Pemex will ultimately be able to place in the U.S. market more than 100,000 b/d of Maya crude, about one-tenth of Mexico's total exports of Maya. In turn, Mexico will import 45,000 b/d of unleaded gasoline from Deer Park, which will satisfy part of Mexico's current need for imported gasoline. Pemex is exploring similar joint ventures with other U.S. Gulf Coast refiners which have capacity to process Maya crude, or for which upgrade costs would be lower than for refineries in Mexico.

A second option is foreign participation in new refinery capacity in Mexico which could process high-sulfur resid into lighter fractions such as gasoline. Pemex is considering such a venture with Valero. At issue in any such arrangement is Mexico's constitutional provision against foreign ownership in the refining of Mexican oil. How this is resolved for the proposed Valero project could set the stage for additional ventures. Some form of joint venture could afford the most dramatic solution to the constraints faced by Pemex.<sup>28</sup>

What does all of this mean for U.S. and Canadian gas exports to Mexico? Pemex has the power to restrict natural gas imports to levels it believes justified. Pemex is also focused almost exclusively on oil and, in particular, Mexico's need to find uses for its Maya crude in order to free its lighter crude oils for export. For these reasons, Pemex has had an incentive to discourage large users of high-sulfur resid from switching from oil to gas.

27. Pemex is, however, evaluating the prospect of a large coking unit possibly located in Salina Cruz (comment from Pemex).

28. Our interpretation of Pemex's strategies with respect to its heavy fuel oil are derived from U.S. industry experts, authorities at Pemex, and announcements of projects in the major industry trade journals.

Yet, Pemex, the CFE, and major industrial operations are feeling great pressure to improve air quality in Mexico's larger cities. Natural gas imports can serve a short-term need until longer-term measures, such as installation of stack gas scrubbers, are taken. Pemex and the CFE are at odds over which measures should be pursued, installation of scrubbers (favored by Pemex) or expansion of refining capacity (favored by the CFE). In the meantime, Mexico is likely to import natural gas from the U.S. and Canada on an as-needed basis in order to clean up some of the more polluted areas in northern Mexico.

#### *Will Pemex Meet its Capital Funding Targets?*

Our discussion of the capital investment constraints faced by Pemex reiterates a key point in assessing the potential for longer term natural gas exports to Mexico—as petroleum investment goes, so goes Mexico's needs for imported gas to satisfy incremental demand. Most observers would conclude that investment constraints will limit increased natural gas production in Mexico for some time to come. The world being an unpredictable place, this type of conclusion may not be warranted. Improved global economic conditions will loosen world capital markets and allow Mexico, with its healthier economy, to secure financing. The NAFTA, with new incentives for foreign investment in some of Mexico's petroleum sectors, will lead to expanded production and improved infrastructure. With Mexico directing 56% of its crude oil exports to the United States (U.S. GAO, 1992), it will benefit the United States to work with Mexico to achieve some of the aims of Pemex's capital program. Moreover, the privatization of Mexico's upstream petroleum business looms as a possibility (although a remote one) and an option for drawing on private investment to expand natural gas production in Mexico. However, Pemex may seek to avoid the necessity of directing a greater proportion of its capital budget to natural gas or of dealing with the acutely sensitive issue of foreign participation. In public discussions by Pemex executives in the United States during late 1992-93, the stance was taken that natural gas demand in Mexico may be overestimated. Pemex may be seeking to shift the focus away from potential shortfalls in domestic production, or to stem the loss of markets for its high-sulfur resid. Or it may be that Pemex feels that incremental demand for gas can be served most effectively by imports.

#### *What are the Prospects for Reduced Availability of U.S. and Canadian Gas?*

We argued above that the longer term trend seems to be one of favorable prices for U.S. gas for some time to come, so that Mexico will have a continued incentive to import. Higher prices for U.S. gas would stimulate

drilling activity, so that any sustained tightening of supply is likely to be short-lived. In addition, gas must compete with many other fuel choices. The same holds true for Canada, where drilling activity has accelerated in response to lower deliverability after the 1992-93 heating season. Although Canadian deliverability declined in 1992, Canada still has about 70 Tcf of remaining established conventional reserves and substantial potential conventional and unconventional reserves (Linder, 1993). An important point is the extent to which we now have a truly continental gas market, with gas flows adjusting to meet disruptions (as they did in Alberta during winter 1992-93). Integration of the North American gas market is such that it is no longer possible to examine any gas situation on a stand alone basis (Linder, 1993). While these developments are generally positive for natural gas consumers, lessening the potential for supply curtailments and price spikes, we do acknowledge that a series of severely cold winter heating seasons, preceded by inadequate resource development, could tilt the North American supply-demand balance in a less optimistic direction for the longer term.

### *Other Considerations*

We raise three last caveats to any long-term outlook for gas flows from the United States and Canada to Mexico. The first is the extent to which a counterclockwise gas flow may develop in Mexico. Pemex expects to increase domestic gas sales to its northeastern markets and to resume exports of gas to the United States through interconnects in northeastern Mexico. As alluded to in our review of cross-border transmission infrastructure, expanded pipeline capacity at interconnect points will enable Mexico to access easily major U.S. markets, with a potential capacity of about 1,600 MMcf/d. However, the difficulty in satisfying gas consumption in northwestern Mexico with domestic production may serve to preserve the gas import market there indefinitely.<sup>29</sup>

Second is the size of natural gas reserves in Mexico, as emphasized by Foss and Johnson (1991). The prevailing opinion is that Mexico's basins, being less exploited for their gas, harbor a substantial resource. While there is much debate about the true extent of economically recoverable gas in Mexico, and reserve-to-production ratios for the United States and Canada mainly reflect better inventory management, the point remains that Mexico is expected to be an important natural gas exporter in the future. The United States affords greater long-term market potential for Mexican gas than the reverse. In 1992, the United States consumed approximately 20.1 Tcf of gas compared to Mexico's

29. Public comments from Pedro Carlos Gomez, Pemex Gas, at a conference sponsored by University of Houston, *North American Natural Gas Markets and Policy Issues*, June 18-19, 1992.

estimated 4 Tcf. Canadian and U.S. suppliers will eventually have to compete with Mexican gas.

Finally, we must consider increasingly open trade in all of Latin America and the Caribbean Basin. Already, prospects of an approved NAFTA agreement have triggered interest among other Latin American countries in negotiating trade agreements with their northern neighbors and each other. Culmination of U.S.-Caribbean Basin initiatives could improve prospects for U.S. imports of liquified natural gas (LNG). Privatization in the petroleum sectors of Argentina, Chile, Venezuela, Peru, and other countries will place increasing pressure on Pemex to develop ways of embracing foreign risk capital. Mexico has prospects for moving natural gas and crude oil south to serve its less well endowed neighbors in Central America. We can only mention these considerations at this juncture. Suffice it to say, a number of factors loom ahead which could alter North American energy balances.

## CONCLUSIONS

We opened this paper by asking whether the United States and Canada would be long-run suppliers of gas to Mexico. We conclude with the following observations based on our analysis.

1. Mexico should remain a net importer of natural gas for at least the next 10 years. At some point, a counter-clockwise flow of gas will develop, with Mexican gas re-entering the United States through northeastern Mexico. Mexico will continue to take imported gas for use in its northwestern markets indefinitely.
2. Conversion from residual fuel oil to natural gas in Mexico's electric power and non-petrochemical industries would have the greatest impact on gas import volumes. Mexico's current usage of gas is quite limited. Consequently, the problem Pemex faces in finding markets for the displaced high-sulfur resid poses the greatest constraint to increasing the levels of natural gas imported by Mexico.
3. Apart from the constraint posed by fuel oil use, for the time being there appears to be a rational quantity for natural gas imports to meet incremental demand. Cross-border transmission capacity almost doubled in 1992, from 559 MMcf/d to 959 MMcf/d, but Mexico continued to take between 300 and 350 MMcf/d. Indeed, new cross-border capacity has served more to introduce competition to transportation rather than to increase imports of gas. We add here that imports of gas by Mexico dropped precipitously during the first half of 1993, due primarily to

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offline maintenance of petrochemical plants. Questions have begun to surface about the strength of demand in this sector, a point we touched upon in our discussion of sources of aggregate demand, and the strength of demand for gas overall.

A reasonable scenario seems to be that Mexico will continue to take imports of natural gas to satisfy incremental demand in the northern part of the country. This suggests a fairly long horizon for imports but not necessarily higher volumes of imported gas.

Ultimately, participation in exploration and drilling activity in Mexico by U.S., Canadian, and other companies may serve to speed up the amount of gas available for delivery to U.S. markets. Of course, all of this is extremely sensitive to how the NAFTA plays out, what provisions for energy the final agreement might contain, and the pace and progress of continued reforms at Pemex. Mexico faces a period of uncertainty as maneuvering around the 1994 presidential elections begins. If President Salinas' initiatives are preserved, then Mexico should see continued improvement in its petroleum sector. It is important to note that while the resumption of gas exports from Mexico would obviously reduce the market potential for U.S. gas sales to Mexico, efforts to prove up Mexican gas reserves and expand and update Mexico's natural gas transmission infrastructure offer a much more beneficial scenario over the long-term, especially if undertaken in an increasingly open trade and investment environment. Participation in development and transportation of Mexico's resource base is a carrot that no U.S. or Canadian company would refuse. For consumers and end users of gas in the huge U.S. market, integration with Mexico and access to Mexico's resource base can only help to support the continuing role of natural gas in the North American energy balance.

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